Testing and Characterization of the Analog Transient Waveform Digitizers for the KamLAND Experiment

A. D. Marino, B. E. Berger, S. Enimoto, F. Bieser, T. Stezelberger, and H. Yaver for the KamLAND Collaboration

The Kamioka Liquid scintillator Anti-Neutrino Detector (KamLAND), currently under construction in Japan, is a long baseline neutrino oscillation experiment which uses Japanese commercial nuclear power reactors as the neutrino source. In the KamLAND detector approximately 4000 Analog Transient Waveform Digitizer (AWTD) ATWDs will be used to digitize the charge signals from the 2000 20-inch photomultiplier tubes (two ATWDs will be used for each PMT). It is necessary to characterize the ATWDs and to develop a mass testing procedure for them to insure that they function properly within the desired range.

The parameters to be studied are the power consumption, the region of linearity, the gain variation, and the timing variation between the ATWDs. The testing was divided into two stages. The goal for the first stage of testing was to identify approximately 50 functional ATWDs. A testing board was made from an existing 12-channel KamLAND data acquisition card that was modified so that the ATWDs were powered from an external power source. This is partially to limit the current a bad ATWD can draw and to measure the current used by the ATWDs. A function generator then produced a 2 volt amplitude triangular pulse which was fed into the ATWDs to locate a 2 V region of linear operation for the ATWDs. Additionally, the number of counts from the highest point to the lowest point was recorded so that the gain variation between the ATWDs could be studied. Also the number of time clicks between successive peaks was noted in order to study the timing variation between the ATWDs.

After the first stage of testing was completed, a common region of linear operation was identified for all for the functional ATWDs. The gain variations of the ATWDs were examined and found to be on the order of 2%. The timing variations were also found to be small.

With the first stage of testing now complete, the goal for the second stage of ATWD testing is to have an automated testing program which will perform a pass/fail test and attempt to locate approximately 5000 good ATWDs. For this testing, the test board is again being modified to include a computer-controlled pulser. During the mass testing, the current draw of the ATWD will be studied and it will be rejected if it is too high or too low. Then several test pulses will be input to the ATWD at different voltages which span the desired range of linear operation. By studying the mean and deviation of the waveforms, ATWDs which have very noisy pedestals will be rejected. Next, using the pulses taken at various voltages, the linearity of the ATWDs will be studied. The slope of this linear region is also useful in studying the gain of the ATWDs. Next the ATWDs will be checked for cross talk between the three channels on the ATWD by sequentially applying pulses to each of the channels and observing the effects on the neighboring channels. For example, if a large change is seen on channel 1 while a pulse is applied on channel 2, the ATWD will be rejected. As a final consistency check, the timing of the ATWD will be examined by finding the rising and falling edges of a pulse with a known frequency.

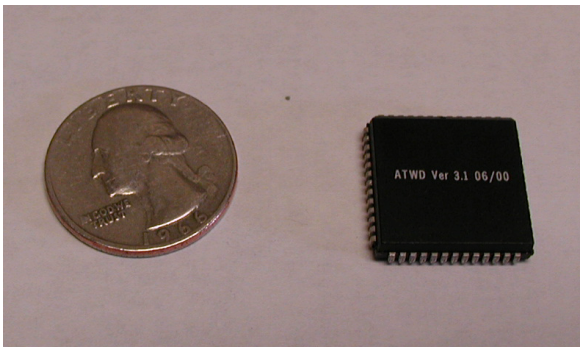

Figure 1: This photograph shows the ATWD sitting next to a quarter.